US-PAT-NO: 6097838

DOCUMENT-IDENTIFIER: US 6097838 A

TITLE: Color correction of a compressed image

DATE-ISSUED: August 1, 2000

US-CL-CURRENT: 382/167, 358/518 , 382/162 , **382/233** , 382/250

APPL-NO: 09/ 306162

DATE FILED: May 6, 1999

PARENT-CASE:

This application is a divisional of application Ser. No. 08/770,765, filed Dec. 19, 1996.

---------- KWIC ---------

Brief Summary Text - BSTX (15):

In accordance with the present invention, there is provided a method for performing color correction of a compressed digital image, comprising the steps of: retrieving from memory a compressed unit of image data; **partially decompressing the compressed unit to produce a partially decompressed** unit representing part of the information describing a

region of the image in a
first color space; performing color correction on
the **partially decompressed**
unit to produce a corrected unit in the first color
space; subsequently
decompressing the entire corrected unit to produce
decompressed, corrected
image data; and converting the decompressed,
corrected image data into a second
color space image for rendering.

Detailed Description Text - DETX (19):
Having described the general operation of a
printing system employing the
present invention, attention is now turned to
specific details of the operation
of the compression and decompression blocks (64 and
72) working in conjunction
with image processors 66 and 72. With reference to
FIG. 2 there is depicted a
flow diagram illustrating the various processing
steps in which processing of
the image data is accomplished. Initially,
compressed image data in the form
of a digital document 100 comprising a plurality of
coded or compressed units
(representing the compressed color image in a
three-dimensional color space
such as YC.sub.r C.sub.b), is provided to **partial
decompression** block 102.
**Partial decompression block 102 is intended to
partially decompress** the coded
units. For example, in the preferred JPEG image
compression embodiment
depicted in FIG. 3, the coded units are
decompressed into a series of discrete
cosine transform (DCT) coefficients using: (a) a
variable length (Huffman)
decoding operation 200; (b) an N.times.N sub-block

extraction operation 202;
followed by (c) an inverse DCT operation 204,
performed only on the N.times.N
sub-block of coefficients. The result of the
partial decompression step is a
partially decompressed image 104, including the DC
coefficient and possibly AC
coefficients as well, as will be described below.

Detailed Description Text - DETX (20):
It will be appreciated that the DCT coefficients
within the **partially**
decompressed image data 104 may be processed using
color correction or
adjustment operations, particularly applied to the
DC and low order AC terms.
These terms may be processed using matrix-based or
tetrahedral interpolation
operations on the N.times.N coefficient set to
accomplish the color correction
for the DC and low order AC terms, with the
understanding that the higher order
AC coefficients will have little impact on the
perceived color of the block.

Detailed Description Text - DETX (21):
Referring to FIGS. 2 and 3, the **partially**
decompressed data is provided to
the first phase color correction block 108 where
tetrahedral interpolation
processing is performed to complete the color
correction transformation.
Recognizing that the most visually significant
information is represented in
the first few coefficients for each DCT block (the
DC component indicating the
average color), this data serves as the basis for
the first color correction

transformation. The color correction operation may be generally characterized as a function that maps a set of device independent or visually based color coordinates, for example, YC.sub.r C.sub.b to a corresponding set of device coordinates Y'C.sub.r 'C.sub.b '. Due to the complex nature of this function, it is usually implemented as a three dimensional (3-D) lookup table with 3-D interpolation. It is important to note that the color correction function does not change the orientation of the color space (in this example, a luminance dimension Y, and two chrominance dimensions C.sub.r, C.sub.b). Rather, it alters the

Detailed Description Text - DETX (29):

Once the first phase color correction transformation has been accomplished at step 108, the data is again **partially decompressed,** but now is in the form of a device-dependent color space 110. In the JPEG compression embodiment, depicted in FIG. 3, the **partially decompressed,** device-dependent data is then integrated or merged (block 208) with the remaining, unprocessed DCT coefficient data before being completely decompressed as represented by complete decompression block 112 in FIG. 2 and inverse DCT compression block 210 in FIG. 3. Once fully decompressed data 114 is obtained as the result of the complete decompression operation 112, the decompressed data is passed to the second phase color correction, block 118. This phase performs a simple

color space conversion to the printer signals, C, M, Y, K. For example, if the first phase color correction is a mapping from device independent YC.sub.r C.sub.b to device dependent Y'C.sub.r 'C.sub.b ', then the second phase maps device dependent Y'C.sub.r 'C.sub.b ' to the printer signals CMYK. This would be accomplished in several steps, all of which would be substantially simpler than the first phase color correction. First, a 3.times.3 matrix may be used to map Y'C.sub.r 'C.sub.b ' to CMY as follows: ##EQU9## where Corr. Coeff represents the coefficients of the 3.times.3 matrix.

Detailed Description Text - DETX (32):

Also depicted in FIG. 2 is an optional series of operations 130 that would be carried out in accordance with yet another alternative embodiment. In optional section 130, the **partially decompressed** data 110 may be recompressed and stored, block 132, and subsequently retrieved and **partially decompressed,** block 134. The intent of the alternative embodiment is to generally represent those operations that might be employed if the image being processed were not going to be immediately rendered by an output device. For instance, in the JPEG image compression embodiment, the recompression and store operation would take the **partially decompressed** device-dependent data, merge it with the remaining DCT coefficient data, recompress the merged DCT data (e.g., Huffman encoding) and store the data as a compressed JPEG

image. Subsequently, when the image is to be rendered, it is retrieved and decompressed completely, resulting in decompressed data 114 which may be further processed as previously described with respect to the second phase color space transformation. In yet another alternative embodiment, the operations depicted in FIG. 2 may be accomplished during the compression of a color image so as to produce a compressed image for storage as described with respect to the optional operations 130.

Detailed Description Text - DETX (46):

In general, one need only conduct whatever **partial decompression** steps are required to reveal the color values for the compressed image. One need not complete the decompression by determining where within the image the color values belong. The color correction can then be applied to the revealed color values. The resulting **partially decompressed** image can then be either recompressed or fully decompressed as desired.

Claims Text - CLTX (3):

partially decompressing the retrieved compressed unit to produce a **partially decompressed** image representing the color of a region of the digital image in a first color space;

Claims Text - CLTX (4):

performing color correction on the **partially**

decompressed unit, to produce a corrected unit in the first color space, by mapping at least a first color of the region in the first color space to a corresponding second color in the first color space using an interpolation process to complete the color correction transformation;

Claims Text - CLTX (5):
subsequently **partially decompressing** the corrected unit to produce decompressed, corrected image data having the form of a device dependent color space;

Claims Text - CLTX (6):
integrating said **partially decompressed** device dependent image data with the remaining compressed data before completely decompressing this result to form a fully decompressed data block; and

Claims Text - CLTX (16):
7. The method of claim 6, wherein the step of **partially decompressing** the compressed unit produces a set of DCT coefficients and where the step of performing color correction comprises:

Claims Text - CLTX (24):
12. The method of claim 1 wherein the steps of **partially decompressing** the compressed unit and performing color correction on the **partially decompressed** unit are carried out upon only a subset of the

compressed data representing the
region of the image, the method further comprising
the steps of:

Claims Text - CLTX (25):
merging the subset of color space transformed data with the **partially decompressed** unit;

Claims Text - CLTX (26):
recompressing the **partially decompressed** unit to generate a second
compressed unit; and

Current US Cross Reference Classification - CCXR (3):
382/233